View metadata, citation and similar papers at core.ac.uk
brought to you by CORE
provided by European Scientific Journal (European Scientific Institute)

European Scientific Journal June 2015 edition vol.11, No.16 ISSN: 1857 – 7881 (Print) e - ISSN 1857- 7431

RELATIONSHIP BETWEEN LEARNING OUTCOMES AND PEER ASSESSMENT PRACTICE

Adeyemi Alaba Adediwura, PhD
Dept. of Educational Foundations & Counselling,
Obafemi Awolowo University, Ile-Ife

Abstract

The study examined the effect of peer assessment on students' mathematical retention ability and determined the effect of peer assessment practice on the students' attitude towards mathematics learning. It also established the relationship between students' attitude towards mathematics learning and peer assessment practice. These were with a view to improving students' learning of mathematics. The population and the sample consisted of 45 private students in a remedial class who were preparing for Senior School Certificate Examination (SSCE) after an unsuccessful attempt at the end of their three years senior secondary school programme. Four instruments were employed for data collection. The instrument includes; Assessment Tasks (AT) used at the end of every mathematic teaching/learning process', Students Attitudes towards Peer Assessment (SAPA) questionnaire, Students' Attitude towards Mathematics (SAMS), Mathematics Post Training Test (MP2T) and a Mathematics Retention Test (MRT). The results showed that the peer assessment practice has a significant effect on the retention ability of the students ($t = 1.83$, $df = 44$, $p > .05$) and ($r = 0.97$, $p < .05$). The results also showed that the effect of peer assessment practice on students' attitude towards mathematics learning is significant ($t = 11.46$, $df = 44$, $p < .05$). Furthermore, the results showed that there is no significant relationship between students' post training attitude towards mathematics and attitude towards peer assessment practice ($r = -0.064$, $p > .05$). In conclusion peer assessment as adopted and use in this study may be said to be one of the possible alternatives assessment methods that will serve assessment formative functions and thus bring about improvement in students' learning of mathematics

Keywords: Learning Outcomes, Peer-Assessment, Attitude towards Mathematics, Attitude towards Peer-Assessment

Introduction

In Nigeria educational system examination-oriented assessment methods have for a very long time dominated assessment practices in all level of schools with rare use of assessment practices such as peer-, authentic-, portfolio- and self-assessment. Researches had shown that the use of examination-oriented methods may result in superficial and rote learning and low motivation in learning (Morrison & Tang, 2002; Schoenfeld, 2007). Furthermore, it has been proven that students often play a passive role under the examination-oriented approach, most of them do not understand the learning goals and assessment requirements. This being the case, students may work hard in a wrong direction and achieve low performance, leading them to a "learning helplessness" situation (Black & Wiliam, 2009; Spinelli, 2006).

In the last ten years Senior School Certificate Examination (SSCE) results as released by West Africa Examination Council (WAEC) and National Examinations Council (NECO) showed that less than 35% of students who enrolled for Mathematics pass the subject at credit level. This low mathematical literacy proficiency level remained consistent over the years. Schoenfeld, (2007) reported that students' mathematical proficiency may not be developed when the learning process mainly consists of drill exercises which mainly encourage achieving high marks in tests or exams but not the learning of mathematics. Students are considered proficient in mathematics when all strands of proficiency are developed (Kilpatrick, Swafford, & Findell, 2001). The current assessment methods in Nigeria which focus on selection and measurement purposes are inadequate for the assessment purpose and do not encourage the development of the mathematical proficiency. Over reliance on the examination-oriented methods also leads to much failure experience, which poses negative influence on students' productive disposition. It is therefore necessary for the realization of Nigeria goal of becoming a technological developed nation to engage students actively in the assessment process and to make the assessment a tool for the balanced development of each of students' strand of mathematical proficiency.

It is hard to set a standard to describe when an individual is proficient in mathematics since the definition of proficiency changes through time (Kilpatrick, Swafford, & Findell, 2001). Ramaley (2007) points out that in today's curriculum, mathematics teaching and assessment are still led by the education-traditionalist mode philosophy of education, which is widely criticised (Schoenfeld, 2007). In this mode, the teacher controls the class and students are expected to receive knowledge in a classroom environment which emphasizes discipline, and assessment is conducted by paper-pencil tests (Schoenfeld, 2007). Before looking for effective alternative assessment

methods which are suitable for the new goals of mathematics education, it is important to find a widely accepted definition of mathematical proficiency for the 21st century.

A widely adopted framework of mathematical proficiency is proposed in "*Adding it up*", in which the authors identify five aspects of competence to describe what the students should achieve to be successful learners in mathematics: conceptual understanding, procedural fluency, strategic competence, adaptive reasoning and productive disposition (Kilpatrick, Swafford, & Findell, 200). *Conceptual understanding* refers to the understanding of concepts, representations and operations. *Procedural fluency* emphasizes the skills to conduct the procedures. *Strategic competence* involves the ability of problem solving, including to plan, to represent and to solve problems. *Adaptive reasoning* includes the ability to explain, justify and prove a mathematical work. *Productive disposition* refers to students regarding mathematics as a useful subject and to the belief of the worthiness to dedicate their efforts in mathematics. These five strands of proficiency are interconnected in the development of students' mathematical proficiency (Kilpatrick, Swafford, & Findell, 2001).

In Mainland China, mathematics learning is built upon three dimensions of objectives: "knowledge and skills", "process and methods", "affect, attitudes and values" (MOC, 2001, translated by Cheung & Wang, 2003), which are equivalent to "conceptual understanding", "procedural and strategic competence" and "productive disposition" correspondingly. It is imperative that Nigeria mathematics curriculum must include instruction and assessment of mathematics need to be designed to facilitate the development of all these dimension of proficiency. In short, researchers generally agree on the need to develop the five strands of proficiency, although different terms or classifications have been proposed. Schoenfeld

(2007) points out that it is difficult to assess students' strategic competence (problem solving), adaptive reasoning and productive disposition and tests which mainly focus on skills or procedures may eventually lead to insufficient development of the other strands of proficiency.

At the classroom level, mathematics assessment aims to measure students' performance in learning and inform teachers and students about the status of learning (Stiggins, 2001). Based on the information provided by the assessment, students know what they should improve and teachers can adjust the instruction. However, mathematics assessment overwhelmingly relies on paper-pencil tests, where students work individually on problems and those tests usually fail to assess whether the students are proficient or not (Schoenfeld, 2007). Furthermore, such tests may bring side effects such as "test score inflation" and "illusion of competence", which lead to unbalanced

development of strands of proficiency (Onion & Javaheri, 2011; Schoenfeld, 2007). From the poststructuralist point of view, Klein (2012) notes that "marking with tick and cross" as one of the discursive practices in mathematics learning may limit students' thinking when answering questions (Klein, 2012). Thus, such assessment methods are far from being adequate to be the only assessment method in learning. Alternative methods are required to obtain valuable information about the students' performance in all strands of mathematical proficiency which promotes a balanced development in each strand of proficiency, especially the strategic competence, adaptive reasoning and productive disposition. Peer assessment may complement examination-oriented methods and serve to facilitate the development of mathematical proficiency: it allows students to participate actively in each part of the assessment process and provides more opportunities for students to think, to explain and to argue on mathematics and provide more meaningful feedback for students.

Peer assessment can be defined as an assessment method in which students score quantitatively or comment qualitatively on their peers' performance in an educational setting (Strijbos, & Sluijsmans, 2010). It differs from traditional assessment mainly in terms of the degree of student involvement and interaction. Topping (2009) remarks that "peer" refers to learners with equal status. In this study, peers refer to students who study in the same class. Peer assessment can either be an assessment tool or an assessment for learning and its functions can either be summative or formative (Gielen, 2007; Sluijsmans, Moerkerke, Van Merriënboer, & Dochy, 2001; Topping, 2009). How students assess others varies across different purposes. Some common ways are marking, giving written comments or feedback, face-to-face conversation, or assigning exercises to peers (Hodgen & Wiliam, 2006; Topping, 2009). The objects to be assessed can be writing, presentation, group work, assignment or skills (Sluijsmans et al., 2001; Topping, 1998; 2009). Given the wide scope of peer assessment, this study focuses on involving students to make judgement to their peers' assessment tasks and provide narrative feedback for their peers according to the pre-set assessment criteria. To compensate for the inadequacies of the current assessment methods, this study aims at determining the effect of peer assessment on mathematics learning outcomes (retention ability and attitude towards mathematics learning and peer assessment) among secondary school students.

Researchers have summarised studies about peer assessment according to its purposes or outcomes. Gielen (2007) reviewed studies about peer assessment from 1952 to 2006 in the major bibliographic databases and summarised five distinctive goals for applying peer assessment as a tool: "for social control, for assessment, for learning, for learn-how-to-assess and for

active participation" (Gielen, 2007; Gielen, Dochy, Onghena, Struyven, & Smeets, 2011). To answer the question "under which specific circumstances are particular types of peer assessment beneficial for particular type of student learning?", Van Zundert, Sluijsmans and Van Merriënboer (2010) analysed 33 empirical studies on peer assessment from 1990 to 2007 and categorized the studies into four groups based on the outcomes of peer assessment: psychometric qualities of peer assessment, domain-specific skill, peer assessment skill, students' attitude towards peer assessment. Studies on psychometric qualities and peer assessment skills have regarded peer assessment as an assessment tool. Research on domain-specific skill and students' attitude focuses on the impact of peer assessment on students' subject matter learning and their learning attitude. Topping (1998) investigated the variables of peer assessment practices based on empirical studies in higher education and he identified seventeen variables of peer assessment practices: subject, objectives, privacy, etc.. He also classified peer assessment with respect to the effect on four aspects: "cognition and metacognition, affect, social and transferable skills and systemic benefits" (Topping, 1998). The first three focuses on effects of peer assessment on learning while "systemic benefits" mainly involve peer assessment as an effective method to substitute or supplement the teacher assessment (Topping, 1998). Synthesizing the previous research peer assessment, three types of studies on peer assessment can be distinguished: peer assessment as an assessment tool, peer assessment for learning and the development of the peer assessment methods.

Through assuming the role of an assessor in peer assessment, students may be more aware of the learning goals, assessment criteria, strategies and evaluation of the tasks. They are also discouraged from being merely exam-oriented, which may lead to superficial learning. Students' understanding of the learning targets is consolidated and deepened through the assessing processes such as reviewing, identifying errors and missing knowledge, providing feedback, explaining, and grasping the distance to the learning goal (Topping, 1998).

Researchers have analysed how peer assessment may facilitate learning from different perspectives. In terms of the implementation of peer assessment, some studies reported positive effects of peer assessment on students' learning performance or perceived learning. For example, students' learning was enhanced through the participation in the creation of the assessment criteria (Orsmond, Merry, & Callaghan, 2004) and through providing or receiving elaborated feedback (Gielen, 2007, pp. 125-154; Li, Liu, & Steckelberg, 2010). As an assessment for learning, peer assessment is a form of peer learning experience (Gielen, 2007; Topping, 1998) in which students learn from each other during the assessment process. In some cases,

peer assessment can be integrated with collaborative learning to maximize the effectiveness of the learning environment (e.g. Lin, Hong, Wang, & Lee, 2011). Peer assessment has also been adopted as an essential strategy in formative assessment (Black & Wiliam, 2009; Hodgen & Wiliam, 2006). Useful information about students' understanding, such as whether students are able to assess accurately on peers' task or provide correct explanation of their judgments, can be obtained by observing students' performance in the peer assessment when compared with the mere evaluation from their written tasks. As more responsibility and awareness on the learning goals and assessment criteria are required from the students, studies also reported that peer assessment leads to more self-regulation and reflection in students' learning (Egodawatte, 2010; Gielen, 2007; Kim, 2009; Topping, 1998; Van Gennip, Segers, & Tillema, 2010; Vickerman, 2009).

Although peer assessment is generally believed to be beneficial to students' learning, the effectiveness of peer assessment varies across subjects and learning contexts (Topping, 1998; 2010). Differences in the design of peer assessment may account for the inconsistent empirical findings. In fact, no fixed peer assessment method can be applied to all learning contexts. Rather, in line with Ploegh, Tillema, & Segers (2009) and Tillema, Leenknecht, & Segers, (2011), this paper argues that by fulfilling certain quality criteria of the steps, peer assessment can be designed to achieve the desired goal according to the need of the subjects or the local national policy on education. The framework put forward by Ploegh et al. (2009) and Tillema et al. (2011) enables the practitioners to design peer assessment by considering the quality criteria for each step. However, the applicability of Ploegh et al. (2009) and Tillema et al.'s (2011) framework for use in Nigerian educational system have not being empirically ascertained, thus, the current study fills the research gap by applying their framework in investigating effect of peer assessment on students attitude toward mathematics learning and mathematical proficiency retention ability of Nigerian students as well as establishing the relationship between students' attitude towards mathematics and attitude towards the use of peer assessment.

Purpose of the Study

Specifically the objective of the study includes to

1. examine the effect of peer assessment on students' mathematical retention ability,
2. determine the effect of peer assessment practice on the students' attitude towards mathematics learning; and
3. establish the relationship between students attitude towards mathematics learning and peer assessment practice.

Hypotheses

1. Peer assessment practice does not have a significant effect on students mathematical retention ability
2. The effect of peer assessment on students' attitude towards mathematics learning is significant
3. There is no significant relationship between students' post training attitude towards mathematics and attitude towards peer assessment practice.

Methods

Population and Sample

The population and the sample consisted of 45 private students in a remedial class who were preparing for Senior School Certificate Examination (SSCE) after an unsuccessful attempt at the end of their three years senior secondary school programme. All the 45 students were involved in the study. The study made use of a quasi-experimental design without a control group. The 45 students were espoused to six weeks training and use of peer assessment along with mathematics teaching /learning.

Instruments

Four instruments were employed for data collection. The instruments include; assessment tasks used at the end of every mathematic teaching/learning process', students attitudes towards peer assessment questionnaire, students' attitude towards mathematics questionnaire, mathematics post training test and a mathematics retention test.

Assessment tasks comprised tasks assigned to at the end of each day mathematics teaching/learning process to be solved in each group and take home task to be solved individually. The topics involved were on the topics "Algebraic fractions", "Inverse proportional function" and "Pythagoras theorem", chosen based on teaching schedule. Assessment tasks were delivered during the middle of the learning topic, and in turn they also served as learning tasks to enhance students' performance in the summative assessment (Carless & Liu., 2006). Students completed the assessment tasks in pairs without referring to any textbooks or notes.

Students' Attitudes towards Peer Assessment (SAPA) Questionnaire was adapted from CHAN (2013) Questionnaire of Students' Views towards the Implementation of Peer Assessment (QSVIPA). The QSVIPA was a 25 item five-point Likert scale questionnaire and three to five open-ended questions about students' views towards the peer assessment process. SAPA contained 25 attitude generating statements of desired behaviours designed to find out the attitude of students toward the implementation process of peer assessment. The students were requested to respond to each of the items on

the attitude generating statements on a 4-points continuum; strongly agree, agree, disagree, and strongly disagree. The reliability index of the instrument was 0.84 and the construct validity coefficient of the instrument using discriminant procedure was 0.28, this shows that the instrument has construct validity.

Students' Attitude towards Mathematics Scale (SAMS) designed and validated by the researcher was used to measure students' attitudes towards mathematics. The instrument contained 24 mathematics attitude generating statements on a 4-points continuum; strongly agree, agree, disagree, and strongly disagree. The reliability index of the instrument was 0.78 and the construct validity coefficient of the instrument using discriminant procedure was 0.31.

Mathematics Post Training Test (MP2T) and Mathematics Retention Test (MRT) were researcher self-developed 40 multiple choice objective mathematics tests that was based on the five mathematics topics taught during the six weeks training. The MP2T and MRT were content valid with a test-re-test reliability estimate of 0.81 and 0.75 respectively.

Procedure

The training and use of peer assessment along with mathematics teaching /learning process lasted for six weeks July 1st to August 8th 2014 and each day session lasted one hour.

On the first day July 1st, SAMS was administered on the students after which they were introduced to peer- assessment process. The introduction involved: explaining to students what peer assessment is; it purposes; assessment as support for learning; meaning of assessment; and peer assessment as a means of helping a friend. At the end of the training session students were allowed to ask questions and were made to get prepared for the use of peer assessment in the course of their remedial programme. From 2nd to 4th July students were taught "Simplification of Surds", "Operation with Surds" and "Surds in Brackets". At the end of the first two days teacher marked assessments were carried out, but on 4th of July peer assessment was carried out with the teacher setting criteria for the assessment task. On Monday 7th July introduction to peer assessment continued with explanation on five steps of peer assessment which includes: Selection of the assessment tasks by the teacher according to the learning topics; Finishing the assessment tasks; Setting criteria for the assessment task; Assessing peers' task; and Interpreting the appraisal and correction of the task. From 8th to 11th July "Theory of logarithms" was taught with daily assessment task and home works. These were peer-assessed based on criteria for assessment task set by the students under the supervision of the teacher. On the 14th of July which marked the beginning of the third week, the five

steps of peer assessment was revised, previous peer assessment feedbacks were reviewed and discussed by the students with guides from the teacher and areas of improvement (such as setting up criteria for assessing task; requiring feedback from the assessors; assessing peers' task based on the pre-set assessment criteria, not the personal preference; and interpretation of the peer feedback were discussed). From the 15th to 18th of July students were taught "Linear and quadratic equations" and the assessment followed the second week pattern. Monday 21st July which was the beginning of the fourth week started with a session on peer assessment training. During the one hour session a review of third week peer assessment activities were carried out. The review looked at and discusses the improvement in students' ability to carry out adequate assessment of their peers in terms of being able to: connect to the knowledge points when setting up the assessment criteria; ask questions about specific knowledge or difficulty when requiring feedback from the assessors; explain the judgments by providing which step(s) is (are) the judgment based on; and students ability in writing narrative feedback. In all these areas students were found to have an improvement over what they were able to do in the last three weeks. The review was followed with a revision of the purposes of the peer assessment. Students were then taught "Algebraic Expression" for the rest of the week with assessments that followed the previous week's pattern. The last session on peer assessment training on the implementation of peer assessment took place on the 28th July with more training on: how to assess according to the assessment criteria; what an assessor can do if the judgment cannot be decided following the suggested procedures; the differences between "partly fulfilled" and "need to improve"; how an assessor can explain the judgments arrived at; how the assessor can write "strength" and "weakness" of the assesse; how to provide practical suggestions; and how to reply to the classmates' required feedback. The next four days was used for teaching "Formulae and Algebraic Rules" which followed with peer assessed assessment task. On Monday 4th August general revision on the implementation of peer assessment training was done while 5th to 7th August was used for revision on the mathematics topics that were taught in the course of the training. At the end of the 7th August revision exercise SAPA and SAMS were administered on the students. On the 8th of August MP2T was administered on the students. Two weeks after the post training test that is 22nd August the MRT was administered on the students. Data collected were analysed using descriptive statistics, t-test and Pearson Product Moment correlation (r) coefficient.

Results

Hypothesis 1: Peer assessment practice does not have a significant effect on students' mathematical retention ability

To test this hypothesis, students' scores in the mathematics post training test and the mathematics retention test were compared for difference in mean using paired sample t-test statistics. This was done so as to extrapolate the effect of peer assessment on students' retention ability. The result is as presented on Table 1.

Table 1: t-test Showing the Difference in Mathematics Post-Training and Retentions Tests

Tests	N	Mean	SD	t	r
Mathematics Post Training Test	45	74.80	9.93	1.83	0.97*
Mathematics Retention Test	45	74.29	10.12		

** significant at 0.05 level*

The result as presented in Table 1 showed that the difference in post-training test and the retention test was not significant ($t = 1.83$, $df = 44$, $p > .05$). However, the relationship between the scores was significant ($r = 0.97$, $p < .05$). Since the difference in the means was not significant it could be assumed that the peer assessment practice has a significant effect on the retention ability of the students. This is further supported with the significant relationship between the two tests scores that was established, which showed that the same group of students with high marks in the MP2T were also having high marks in the MRT and vice versa. It could therefore, be concluded that peer assessment practice have a significant effect on students' mathematical retention ability, that is the hypothesis is rejected.

Hypothesis 2: The effect of peer assessment practice on students' attitude towards mathematics learning is not significant.

To test this hypothesis, students' pre and post-training attitude score were compared for mean difference using paired sample t-test statistics. The result was as presented in table 2.

Table 2: t-test showing the Difference in Students Pre and Post-Training Attitude towards Mathematics

	N	Mean	SD	t	r
Pre-Training Students' Attitude towards Mathematics Score	45	45.22	14.65	11.17*	-0.044
Post-Training Students' Attitude towards Mathematics Score	45	74.96	9.61		

The result as presented in Table 2 showed that there was an improvement on students' attitude towards mathematics after the training and use of peer assessment along with mathematics teaching /learning process. The t-test value ($t = 11.46$, $df = 44$, $p < .05$) as showed in the Table indicated that there was a significant difference between students' pre and post- peer assessments attitude towards mathematics. The improvement in

students' attitude however, was independent of their attitude before the training and use of peer assessment along with mathematics teaching /learning process as indicated with the non-significant r value (-0.04) obtained. Thus, it could be concluded that the effect of peer assessment practice on students' attitude towards mathematics learning is significant, that is the hypothesis is rejected.

Hypothesis 3: There is no significant relationship between students' post training attitude towards mathematics and attitude towards peer assessment practice.

To test this hypothesis, students post-training in SAMS score were correlated with their score in SAPA using Pearson Product Moment Correlation. The result was as presented in Table 3.

Table 3: Relationship between Students' Attitude towards Peer-Assessment and Attitude towards Mathematics

	N	Mean	SD	r	p
Students' Attitudes towards Peer Assessment	45	78.69	12.72	-0.064	0.677
Post-Training Students' Attitude towards Mathematics Scale	45	74.96	9.61		

Table 3 presented students' mean attitudinal scores ($\overline{X}$ =78.69, $\overline{X}$ =74.96) towards peer assessment and mathematics respectively as well as the correlation coefficient value (r = -0.064) which indicated a non-significant relationship with the (p > .05). It thus, implies that there is no significant relationship between students' post training attitude towards mathematics and attitude towards peer assessment practice. The hypothesis therefore accepted.

Discussion

The training and implementation of peer assessment in this study gave the students opportunity to set the assessment criteria; explain their judgments; provide feedback; and discuss their assessment with their peers and the teacher through which their ability to use mathematical language to express their ideas was improved. The assessment criteria and written explanation from students also reflect their improvement on using mathematical terms where most students were able to write the assessment criteria using complete sentences and provided evidence to support their judgments in relation to the learning content. Moreover, students changed from simply soliciting correct answers to seeking information for content-related problems. Students' improvement in using mathematical terms may have helped them to express their difficulties thereby providing them with more information that could their retention ability. Researcher have pointed

out that students' ability to use mathematical languages may help them to develop understanding of mathematics (Leung, 2005; Oxenford O' Brian, Nocon, & Iceman Sands, 2010; Roicki, 2002). It could be put forward that training and engaging students in the peer assessment process which involves setting up assessment criteria, writing narrative feedback and discussing with peer equipped them with skill and ability to apply mathematical language. This may contribute to their understanding of mathematics and thus improve their retention ability as revealed in this study.

Peer assessment practice enhancement of students' ability to express their ideas in mathematical terms improves their adaptive reasoning by providing them with the necessary conditions for conveying their mathematical ideas more efficiently. This was inline with Klein (2012) that points out that students build their learning through writing, talking and interacting with peers. Providing the students with the necessary conditions for conveying their mathematical ideas more efficiently may the reason for the significant improvement in students attitude towards mathematics as obtained in this study. This idea was further supported based on a theory that students' development of thinking is a dialectic between their thought and their language, providing an environment for students to use "language", including writing and speaking about mathematics, supports students' metacognitive thinking and mathematical reasoning (Pugalee, 1999). Peer assessment helps the students understand their learning progress through assessing peers and being assessed by peers, as students obtain valuable information about their learning progress through receiving peers' feedback. Yang and Tsai (2010) view that more self-reflection and self-correction can be stimulated by the uncertainty on the accuracy of the peer feedback (as cited in Gielen, 2007, p.126) is an indication that argument and discussion that followed peer feedback provides the students with better understanding which will invariably improve their interest in solving more mathematical problems. That means the reserved attitude towards peer feedback may contribute to the students' development of reasoning and improvement in attitude towards mathematics as obtained in the result of this study.

Students' attitudinal score as measured with the use SAPA can be a bases for concluding that in general students' views towards the implementation of peer assessment are positive. With each day training and use of peer assessment students became more and more positive in the attitude towards the implementation of peer assessment in their class. Students thought that the preparation of the peer assessment practice was adequate and the teacher's feedback and guidance was important for them to learn how to assess. With increasing experience, more students understood what they need to do during peer assessment, felt less difficult to write

narrative feedback, aware of the key learning points and referred back to their own task when assessing others.

A common challenge in the teaching and learning of mathematics is that students tends to hide their mistakes or avoid making mistakes by giving up without trying. After experiencing peer assessment, it was discovered that students were no longer ashamed of their mistakes but instead regarded identifying mistakes by their peers as an opportunity to learn. Besides the fact that students attitude are more positive towards mistakes, peer assessment also provided a more comfortable and supportive environment for the students, as scores are not involved and competition is not encouraged. Students were more active to ask for help and more confident to express their opinions. Students now felt that peer assessment let them understand the importance of helping each other's learning. However, the result of the study showed that the relationship between students' attitude towards peer assessment and attitude towards mathematics was not significant. This result indicates that it is not attitude towards peer assessment that boosted students' attitude towards mathematics but their active participation which gave more opportunity to understanding the principles and language of mathematics.

Implication and Conclusion

This study shows that it is possible to adopt peer assessment systemically in mathematics lessons with the adoption of Ploegh et al. (2009) and Tillema et al.'s (2011) framework in developing peer assessment practices that would support students' mathematics learning. Although students' central role is emphasized in peer assessment, the present study implied that teacher's guidance and ability to modify the method to achieve the desired outcomes is found to be essential to the success of peer assessment. Therefore, an implication to the development of peer assessment is that teachers should input help or revisions gradually based on the students' level of experience and the acceptance to the method, rather than push everything at the same time. In conclusion peer assessment as adopted in this study is examined to be one of the possible alternatives assessment methods that will serve assessment formative functions.

References:

Black, P., & Wiliam, D. (2009). Developing the theory of formative assessment. *Educational Assessment, Evaluation and Accountability, 21*(1), 5-31.

Carless, D., Joughin, G., & Liu, N.-F. (2006). *How assessment supports learning Learning-oriented assessment in action*: Hong Kong University Press.

Chan Ka Man, C. (2013). *Peer Assessment in Mathematics Lessons: An Action Research in an Eighth Grade Class in Macau.* (Published Master of Education Dissertation), the University of Hong Kong.
Egodawatte, G. (2010). A rubric to self-assess and peer-assess mathematical problem solving tasks of college students. *Acta Didactica Napocensia, 3*.
Gielen, S. (2007). *Peer assessment as a tool for learning.* (Published doctoral dissertation),
Katholieke Universiteit Leuven, Belgium. Retrieved from https://lirias.kuleuven.be/bitstream/1979/1033/1/DOCTORAL+DISSERTATION+S.+GIELEN.pdf
Gielen, S., Dochy, F., Onghena, P., Struyven, K., & Smeets, S. (2011). Goals of peer assessment and their associated quality concepts. *Studies in Higher Education, 36*(6), 719-735. doi: 10.1080/03075071003759037
Hodgen, J., & Wiliam, D. (2006). *Mathematics inside the black box*. London: NFERNelson.Huang, R.J. (2007). The status quo ante and prospects of math education in macau. *Hunan Jiaoyu: Mathematics teacher, 2*.
Kilpatrick, J., Swafford, J., & Findell, B. (2001). *Adding+ it up: Helping children learn mathematics*: National Academies Press.
Kim, M. (2009). The impact of an elaborated assessee's role in peer assessment. *Assessment & Evaluation in Higher Education, 34*(1), 105-114. doi: 10.1080/02602930801955960
Klein, M. (2012). *Mathematical proficiency and the sustainability of participation: A new ball game through a poststructuralist lens*. Paper presented at the 35th Annual Conference of the MERGA, Singapore.
Leung, C. (2005). Mathematical vocabulary: Fixers of knowledge or points of exploration? *Language and Education, 19*(2), 126-134.
Li, L., Liu, X., & Steckelberg, A.L. (2010). Assessor or assessee: How student learning improves by giving and receiving peer feedback. *British Journal of Educational Technology, 41*(3), 525-536. doi: 10.1111/j.1467-8535.2009.00968.x
Lin, H., Hong, Z.R., Wang, H.H., & Lee, S.T. (2011). Using reflective peer assessment to promote students' conceptual understanding through asynchronous discussions. *Educational Technology & Society, 14*(3), 178-189.
Ministry of Education of People's Republic of China (MOC) (2001). Ordinary senior secondary mathematics curriculum standards (experimental version). In K. C. Cheung & S. Z. Wang (Eds.).
Morrison, K., & Tang, F.H. (2002). Testing to destruction: A problem in a small state. *Assessment in Education: Principles, Policy & Practice, 9*(3), 289-317.
Onion, A., & Javaheri, E. (2011). Self and peer assessment of mathematical process. *Mathematics Teaching, 224*, 30-32.

Orsmond, P., Merry, S., & Callaghan, A. (2004). Implementation of a formative assessment model incorporating peer and self-assessment. *Innovations in Education and Teaching International, 41*(3), 273-290.
Oxenford O'Brian, J.R., Nocon, H., & Iceman Sands, D. (2010). The use of dialogue and tools to develop students' mathematical language and meta-cognition. *Teacher Development, 14*(4), 447-466. doi: 10.1080/13664530.2010.533487
Ploegh, K., Tillema, H.H., & Segers, M.S.R. (2009). In search of quality criteria in peer assessment practices. *Studies in Educational Evaluation, 35*(2–3), 102-109. doi: 10.1016/j.stueduc.2009.05.001
Pugalee, D.K. (1999). Constructing a model of mathematical literacy. *The Clearing House, 73*(1), 19-22.
Roicki, J. (2008). *Effects of discussion and writing on student understanding of mathematics concepts.* University of Central Florida Orlando, Florida.
Schoenfeld, A.H. (2007). *Assessing mathematical proficiency*: Cambridge university press.
Sluijsmans, D.M.A., Moerkerke, G., van Merriënboer, J.J.G., & Dochy, F.J.R. (2001). Peer assessment in problem based learning. *Studies in Educational Evaluation, 27*(2), 153-173. doi: 10.1016/s0191-491x(01)00019-0
Spinelli, C.G. (2006). *Classroom assessment for students in special and general education* (2nd ed.): Pearson/ Merrill Prentice Hall.
Stiggins, R.J. (2001). *Student-involved classroom assessment* (3rd ed.): Prentice Hall.
Strijbos, J.-W., & Sluijsmans, D. (2010). Unravelling peer assessment: Methodological, functional, and conceptual developments, Editorial, *Learning & Instruction,* pp. 265-269. Retrieved from http://eproxy.lib.hku.hk/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=aph&AN=48891862&site=ehost-live
Tillema, H., Leenknecht, M., & Segers, M. (2011). Assessing assessment quality: Criteria for quality assurance in design of (peer) assessment for learning – a review of research studies. *Studies in Educational Evaluation, 37*(1), 25-34. doi: 10.1016/j.stueduc.2011.03.004
Topping, K.J. (1998). Peer assessment between students in colleges and universities. *Review of Educational Research, 68*(3), 249-276.
Topping, K.J. (2009). Peer assessment. *Theory Into Practice, 48*(1), 20-27. doi: 10.1080/00405840802577569
van Gennip, N.A.E., Segers, M.S.R., & Tillema, H.H. (2010). Peer assessment as a collaborative learning activity: The role of interpersonal variables and conceptions. *Learning and Instruction, 20*(4), 280-290. doi: 10.1016/j.learninstruc.2009.08.010

van Zundert, M., Sluijsmans, D., & van Merriënboer, J. (2010). Effective peer assessment processes: Research findings and future directions. *Learning & Instruction, 20*(4), 270-279. doi: 10.1016/j.learninstruc.2009.08.004

Vickerman, P. (2009). Student perspectives on formative peer assessment: An attempt to deepen learning? *Assessment & Evaluation in Higher Education, 34*(2), 221-230. doi: 10.1080/02602930801955986

Yang, Y.-F., & Tsai, C.-C. (2010). Conceptions of and approaches to learning through online peer assessment. *Learning & Instruction, 20*(1), 72-83. doi: 10.1016/j.learninstruc.2009.01.003